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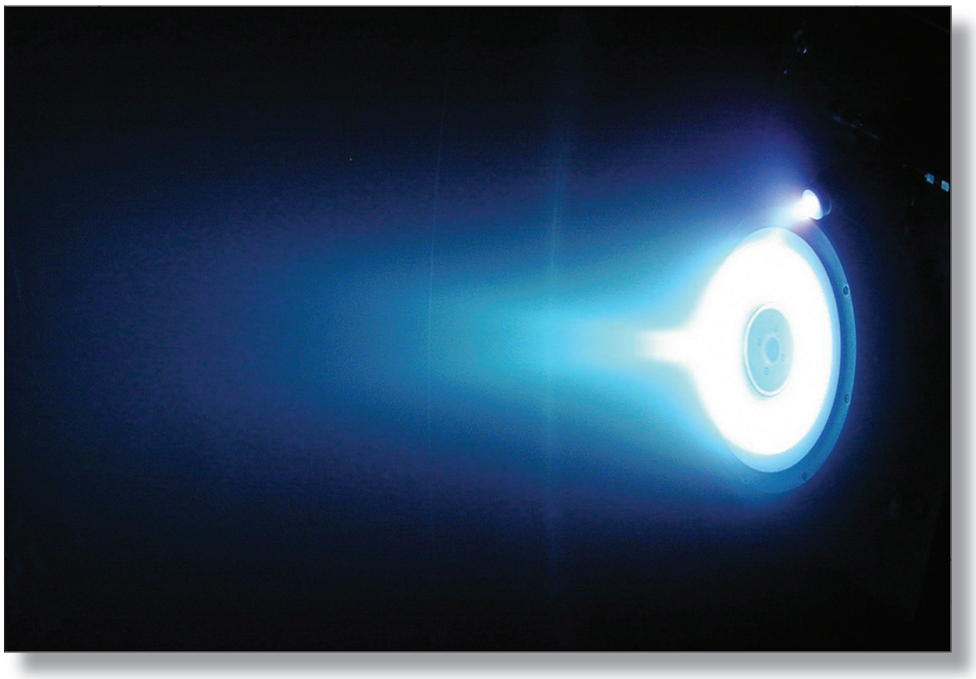
Science and Technology for Tomorrow's Air and Space Force

Success Story

RESEARCHERS DEVELOP CERAMIC MATERIALS AND MANUFACTURING METHODS TO IMPROVE HALL THRUSTER INSULATORS FOR SPACECRAFT



Materials and Manufacturing Directorate researchers along with industry partners identified erosion resistant ceramic materials that could increase the life of Hall thruster components as part of the Integrated High Payoff Rocket Propulsion Technology program. In addition, the directorate expects to lower the cost of the components' manufacturing process by adapting advanced, rapid prototyping techniques, which they expect will shorten the materials' evaluation cycle and allow flexibility in component configuration.

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Accomplishment

Directorate scientists and engineers identified ceramic materials that could increase the life of Hall thruster insulators for spacecraft including satellites and microsatellites.

Background

Hall thrusters are low-thrust electric propulsion devices used on satellites to keep them in the correct orbit and to make orientation adjustments for proper alignment of telescopes and antennas. Electric propulsion is an attractive alternative to chemical propulsion for these applications because, although it produces less thrust, it is more efficient.

Unlike chemical rocket thrusters, which rely on the combustion of propellants and the expansion of hot combustion gases through a nozzle to produce thrust, Hall thrusters use a gaseous Xenon propellant ionized through collisions with electrons emitted from a cathode. An electromagnetic field accelerates and expels the charged Xenon ions from the chamber at high velocity to produce thrust.

Erosion of the ceramic insulators that make up the walls of the discharge chamber currently limits the lifetime of Hall thrusters. The high velocity Xenon ions expelled from the thruster collide with and erode the insulators, eventually degrading thruster performance. Current Hall thruster insulators are composed of boron nitride or boron nitride-silica mixtures, which have good mechanical and thermal properties, but only marginal erosion resistance.

In laboratory-scale screening tests, directorate scientists and engineers identified two ceramics that eroded at rates two to four times less than the current boron nitride materials. The directorate's next step is to fabricate insulators from the erosion resistant ceramics and test them in an actual Hall thruster.

To manufacture prototype insulators from the erosion-resistant ceramics, the directorate partnered with Javelin 3D, a small business located in Salt Lake City, Utah. Javelin 3D will use a rapid prototyping technique called the Laminated Object Manufacturing (LOM) method to fabricate the prototype insulators. LOM is one of a variety of techniques developed to produce parts directly from computer-aided drawings.

Materials and Manufacturing
Emerging Technologies

Additional information

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